The *Antipathes Larix* which I had in my possession had its convolutions crammed with corpuscles resembling in transparency and tint the testicular capsules of *Gerardia*. If it were not rash to come to any conclusion from observations made on objects not in the best possible state, I should say that the sexes are separate, and borne not only by distinct polypes, but even upon distinct polyparies. But I cannot generalize and assert that this is always the case.

The polypary of the true *Antipathes* bristles all over with spinules. These have not escaped other writers, but some of them have erroneously regarded them as abortive branches. The arrangement of these spines may furnish useful characters for the discrimination of the species.

The sarcosoma everywhere covers the polypary, which appears as if enclosed in a sort of distinct sheath. When it contracts, its tissue is traversed by the spicules, as is the case in the *Gorgoniæ*.

The growth of the polypary takes place by the deposition of layers which are superimposed upon the stems, and which at the extremities resemble the fingers of gloves enclosed one within the other. The centre of the axis appears to be perforated by a canal; but this is only an appearance due, in fresh individuals, to the inferior density of the substance which has been added at the extremities and become internal, and, in dried specimens, to the contraction of this substance.

Between *Gerardia* and *Antipathes* there are great differences. In the former the polypary is smooth and covered with very small and scarcely sensible umbilicated elevations; in *Antipathes* it is covered with spinules. The twenty-four tentacles of *Gerardia* correspond with as many chambers separated by the same number of septa with convoluted filaments; in *Antipathes* only two of these convoluted cords are developed, and the tentacles are never more than six in number. In *Gerardia* the Actinian type is as highly developed and characterized as possible; in *Antipathes* it remains incomplete, in consequence of a sort of arrest of development.

XXIV.—*On Clays, containing Fossils, near St. Andrews; with Remarks on some of the latter.* By Robert Walker.

The Clay-bed whose geological position and fossil contents are about to be noticed is situated near the mouth of the Kinness Burn, or rivulet, a small stream that runs past St. Andrews on the south side. Towards the sea this stream has eroded its channel about three feet through the bed. At one time the clay could be seen forming part of the bank on each side of the burn; but, from recent alterations, it can now be seen only on the north side, and there to a limited extent. Taking the utmost stretch of this deposit, it appears not to occupy a superficial area of more than 100 yards each way. Although thus contracted, there is reason to think that it may be the remnant of a more extensive bed which the action of the sea had reduced to its present diminutive dimensions ages ago, when the relative levels of land and sea, and perhaps the outline of the coast, were somewhat different from what they are now. This clay has been known for years to contain shells; little notice, however, appears to have been taken of it beyond occasionally picking out a few *Scrobiculariæ* as they were washed bare by the burn. In this state the matter remained till about two years ago, when the proprietor cut a water-course and a pit for a mill-wheel through the deposit, on the south side of the burn. Although these excavations were not very extensive, they resulted in the turning up of a number of marine shells and some mammalian bones, which had the effect of directing attention more particularly to the subject. A short time afterwards, during the sinking of a well opposite the former excavation, but further from the edge of the burn, a considerable number of shells of different species were again observed. This well was dug 9 feet deep, and the section taken as accurately as possible. In order, however, to test the strata as far as the condition of things would allow, another pit was dug for this purpose, still further from the burn, and higher above the level of the sea than either of the previous excavations, the surface of the ground at this part being about 10 feet above the sea-level.

The following section is from the latter of these pits; and it may be observed that the only appreciable difference between the two sections was in the second bed of the former being somewhat thinner than that of the latter, owing, perhaps, to its proximity to the burn, by which the sand and gravel might have been washed away before the stream cut out its present channel:—

	feet.	inches.
1. Black vegetable earth	1	6
2. Coarse sand, numerous small rolled stones, and littoral shells	2	6
3. Brown sandy clay, few stones or shells	1	4
4. Bluish-brown clay, with here and there thin partings of fine white sand; shells plentiful; the bed not cut through	4	9

The contents of the second bed corresponded in every respect with the materials on the sands at the east of the town at the present day. The contained shells were chiefly *Patella vulgata*, *P. pellucida, Littorina littoralis, L. littorea,* and many broken fragments of other littoral shells. The third bed, although distinct enough, seems to be merely a mixture of the materials of the second and fourth beds; the only shells observed were a few straggling specimens of *Littorina.* In composition, the fourth bed has a greater resemblance to estuary silt than to any other kind of deposit: it shows no traces of lamination, and, with the exception of occasional thin layers of sand, it bears no other marks of stratification. From this bed the mammalian bones and the following shells were obtained; the latter seemed to be distributed through the mass, as far as it was pierced. Of the bivalve shells, the most common was *Tellina proxima,* of which specimens of all sizes were in abundance; and, as usual with this species, the valves were covered with a yellow epidermis, which in most cases, however, adhered more firmly to the clay than to the shell. There were likewise a considerable number of specimens of *Scrobicularia piperata, Mytilus edulis, Cardium edule,* and two or three examples of *Saxicava rugosa.* Of the univalves, *Rissoa ulvæ* was in the greatest abundance—in some places completely crowded, more especially where there was a lamina of sand. *Littorina littorea* was plentiful; there were two specimens of *Nassa incrassata,* and two or three of *Helix hispida.* The univalves were all full-grown specimens; but none of the bivalves, with the exception of *Scrobicularia* and *Tellina,* had attained full dimensions. They were all very friable, and in the case of *Mytilus* and *Cardium* it was scarcely possible, in many instances, to remove them from the clay without breaking. In every instance both valves were adherent; and there can be no doubt whatever that the animals lived and died where their shells were afterwards found. All the marine shells of the preceding list are living in the littoral zone of the adjacent sea, with the exception of *Tellina proxima,* which does not appear to be living now in any part of the British seas, and is considered a characteristic shell of the glacial deposits of Scotland; they are all included in Geikie's Catalogue of Organic Remains from the Glacial Deposits of Scotland*; they are likewise included in Wood's 'Mollusca of the Crag;' so that as species they must have existed during many of the physical changes that have occurred on the earth toward the latter epochs of its history.

Of vegetable remains noticed, there were pieces of the branches of the birch and the oak, together with a few nuts of the latter. Of the birch-branches, however, there was little else than the bark preserved, which did not appear to be at all wasted. There were also a few fragmentary impressions of leaves, and many impressions and remains of what appeared to have been marshplants, with some of the stems in an upright position. There were likewise numerous fibres and rootlets of seemingly various plants. These rootlets and impressions clearly indicate that marshy and perhaps other plants had at one time grown in abundance on this bed; and, so far as observed, this would appear to have been before the third bed was laid down, as no rootlets or stems could be seen in that deposit; and there seems no reason why they should not have been preserved, or traces of them, in the one bed as well as in the other, if they had ever been there. No doubt, from the littoral character of the shells found in this bed, some of them could exist although they were not many feet under water at every tide. Some of the *Tellinæ* can live high upon the muddy shores of estuaries; so can *Scrobicularia.* And, from the large size of these species, it may be inferred that they had found a more congenial habitat than seems to have been the case with *Mytilus* and *Cardium,* whose size and thickness might at the same time be somewhat influenced by the freshness of the water. The three latter species can undoubtedly live in places where the water is as often fresh as salt. Jeffreys says* that the Mussel and the common Periwinkle (*Littorina littorea*) are occasionally found living on the shore in a stream of perfectly fresh water during the recess of the tide, that *Cardium edule* has the same habit, and that the latter species even occurs associated with freshwater Mollusca. It is well known, from the writings of Montagu and others, that *Scrobicularia piperata* burrows in muddy places that are occasionally covered with fresh water, at the mouths of rivers, or far up estuaries. So far as my own observations go, the shell of the latter species retains nearly its normal size and thickness in places where neither *Cardium* nor *Mytilus* seem capable of existing, or, if met with, are always in a thin and dwarfed state. However, there can be no doubt that all the foregoing species could not have lived in situations so high above the sea as to allow even marshy plants to grow. This being the case, the plants must have grown after the bed was raised a few feet higher above the water. For this purpose one of two causes would be necessary: either the land at this time was slowly rising, or the estuary was gradually silted up: perhaps both these operations were going on at the same time, although it would be impossible in the present instance to say which had the chief hand in the matter. At the same time that the land was elevated to some extent, there seems no room to doubt (indeed, according to the observations of Geikie† and others, there appear good reasons for believing) that the land on many other parts of the coast was gradually rising during the deposition of these shell-clays. Whatever may have been the agents engaged in laying down this deposit, whether it has partly resulted from the effect of the waves beating upon exposed banks of boulder-clay, or from the mud borne from the land by glaciers or coast-ice (as suggested by Geikie* to account for the formation of the shell-clays of the west coast), or (what at first sight might perhaps appear equally probable) from the quantity of mud and sand carried down by the Kinness Burn—in either case, the three latter forces all indicate a very different condition of climate from what now prevails in these latitudes: the quantity of water in the burn is now so small; and besides it drains such a limited district that, under the present conditions, its volume could never have been much greater than it is at present. Unless we suppose (as indeed seems probable) that, during the close of the glacial period, it was flooded every summer by the melting of the snow and ice that had collected throughout the preceding winters, it would be difficult to conceive how this small stream could have acted any part in the matter—much less to suppose that, in its present volume, it could have eroded and transported sufficient material to form the accumulation in its present extent, irrespective of what may have been washed away at a later period. This will be more apparent when it is stated that some years ago a pit was sunk into this deposit to the depth of 14 or 15 feet, and the stratum afterwards bored to the depth of 60 feet additional, in search of water, without finding any. This pit was about 40 yards south of the place that yielded the present organic remains, and about 20 feet above the sea. The contractor assures me that during these operations the clay was found to be of a bluish-grey colour, as far as pierced; from which it may be inferred that the bottom of the stratum was not then reached.

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* The Glacial Drift of Scotland.

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* British Conchology, vol. ii.

† The Glacial Drift of Scotland.

From the thickness of this clay, it is evident that a considerable portion of it must be many feet below the sea-level. It would likewise appear to have been deposited in a hollow scooped out of the boulder-clay. The latter can be seen a little further down the stream, extending apparently from beneath the blue clay to the "east sands," where it is occasionally swept bare by the waves from high-water mark to a considerable distance seaward. When thus exposed, the irregular appearance of its surface, and the numerous rolled stones of many sorts and sizes projecting out of the mass, show clearly the unmistakeable characteristics of the boulder-clay. It may be remarked that this is the only place where the boulder-clay can be seen in the immediate neighbourhood. A few years since, it was well exposed, during the excavations for a gas-holder, close by the harbour, about 40 yards further down the burn than the spot where the fossils were obtained.

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* The Glacial Drift of Scotland.

All the other excavations, of late years, made for building and other purposes, along the high ground by the south side of St. Andrews, have merely exposed the brick-clay, which, like the boulder-clay, is of a red colour and of considerable thickness, sweeping down both sides of the Kinness valley. On the high ground there are alternate beds of fine sand and clay; some of the sand-beds are about two feet thick, and sometimes show curious contortions. Though organic remains are not common in these beds, I have sometimes, after a diligent search, found fragments of both bivalve and univalve shells; on one occasion I discovered stalks of an *Equisetum* sticking in an upright position in the clay, 9 feet from the surface, seemingly as they had grown, on a thin layer of vegetable matter. About a year ago, in the cutting of a deep drain through this clay, by the side of the burn, but about a quarter of a mile up from the shell-clay, there was part of the trunk of an oak-tree turned out, which had been deposited in the clay with the branches and acorns. From the profusion of the latter, and their evident attachment to the branches when imbedded, it would appear that the tree had grown at no great distance, and that it had been swept down in autumn. There were also fragments of the birch; and from a bed of drift-gravel intercalated with the clay, the molar tooth of a horse and a molar of a goat were obtained.

The brick-clay is laid thick along both sides of the valley, and can be distinctly traced to within a few yards of the blue or shell-clay. And, although the junction of these strata cannot be satisfactorily seen, from the ground being under cultivation and no section exposed, still it can hardly be disputed (from the position of the beds and the nature of the ground) that the brick-clay underlies the blue clay to some extent on the landward side of the latter. This would precisely agree with the relative positions of the shell- and brick-clays on the west coast, according to Mr. Geikie*. He says, "The red brick-clay sometimes dwindles down to only a few inches in thickness, but is always found between the shell-clay and the hard till" (boulder-clay). From the position and fossil contents of the blue clay in question, there seems little reason to doubt that it is the representative on our east coast, though fragmentary, of the more extensive and prolific shell-clays of the west, and that, like them, it was deposited during the close of the glacial period, while characteristic shells of that period, such as *Tellina proxima*, still lived in abundance on the British shores. Over this glacial bed, marsh- and perhaps other plants had grown and decayed (how long, it would be impossible to conjecture) before the land again began to sink under the sea; during which time the deposit would be exposed to the tear and wear of the waves, when doubtless many of the organisms, together with a great portion of the bed itself, would be washed away. It would be difficult to ascertain, from the manner in which the third and second beds seem to have been deposited, to what extent the land subsided at the time, and whether the subsidence was gradual or rapid. The continuation of the latter of these beds has been noticed at other places in the neighbourhood, at greater elevations. For instance, in a cutting to divert a small stream on the farm of St. Nicholas, about half a mile south of the clay, this littoral deposit was passed through: here it is from 12 to 15 inches in thickness; and the composition and contained fossils are identical with the second bed of the section. At this part the deposit is laid upon a gentle declivity arching round to the Kinness valley, and from 27 to 30 feet above the sea, thus occupying an intermediate position between Dr. Chambers's 64-feet beach at this place and the sea-level; he states, however, that here "the sea has made several shifts of level without indenting the land"*. This stratum was likewise exposed, on the north side of the Kinness valley, about three years since, while altering a wall at the gas-works, at an elevation of 35 feet above the sea, the ground sloping towards the south. This bed was again laid open by the present drainage-excavations; but this time it was on the west side of St. Andrews, at the height of 21 feet above the sea, and contained all the littoral shells enumerated in our second bed.

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* The Glacial Drift of Scotland.

Besides the preceding, there is additional evidence, though of a different kind, of the sea having stood at a higher level than at present, in *recent* times, geologically speaking. This is furnished by an isolated patch of sandstone that crops out at the south end of the "west sands" being quite full of the holes of *Pholas crispata*. This rock is within a foot or two of high-water mark, and about 14 feet above the habitat of the *Pholas* at the present day, which generally lives between 2 to 3 feet above low-water mark and a few fathoms beyond. They do not appear from choice to make their habitations in sandstone, but rather prefer shale or limestone, if these rocks can be had at suitable depths. From the numerous borings in the sandstone in question, it would seem that it had continued for a long time at a depth in the water favourable to the organization of these mollusks; and as the land was gradually elevated, they appear, from their holes still visible here and there in the intervening rocks, to have slowly fallen back to their present station. Additional evidence might be given, from the strata on other parts of the coast, as well as on the authority of various observers, which would go far to show that these recent oscillations of the land had partaken much more of a general than of a local character. The present object, however, is mainly to endeavour to define the geological position of the shell-clay of this district, and to prove, as far as possible from the evidence borne by the strata of the immediate neighbourhood, that the land on this part of the coast had subsided many feet after marshy plants had grown apparently in abundance on these glacial beds.

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* Ancient Sea Margins.

The Mammalian bones already referred to as found in the lower bed, associated with the shells, comprise some bones of an ox and a horse. The remains of the ox (*Bos longifrons*) consist of the frontal bones and horn-cores: the latter are a little larger than those described by Prof. Owen; otherwise there is no difference between them and the description and measurements of this species given in the 'Fossil Mammals.' The bones of the horse consist of part of the cranium, the left tibia, the os calcis of the right side, and a hoof-phalanx. The skeleton seems to have been complete at the time it was discovered; and it is much to be regretted that, owing to its lying on one side of the trench, the rest of the bones were not dug up, in order to allow a more complete comparison between them and the skeleton of the recent species. At the same time, the result of a comparison of these fragmentary remains with the bones of the horse of the present day may not be unworthy of a little notice.

This portion of the skull comprises the superior maxillary, the intermaxillary, the malar, and part of the lachrymal bones, along with a part of the palatine bone of the right side, of the left side, the greater part of the intermaxillary, and the palatal portion of the superior maxillary. All the teeth of the right upper jaw, and the two middle incisors, the canine, and the second molar of the left upper jaw are likewise present. This cranium had belonged to a horse (judging from the condition of the incisor teeth) of not less than six or seven years of age. The respective bones do not differ in shape from the corresponding bones of the recent horse; neither do the grinding-surfaces of the teeth differ, except in the last molar, the enamel and dentine folds being very similar in both. The molar teeth differ, however, from those of the horse of the present day, in the first molar having a less acute anterior angle, and in the smaller transverse diameter of the second and third molars compared with their antero-posterior diameter. So far these characters agree with those of *Equus fossilis*; but the last molar differs from the heretofore recognized characters of the last tooth of that species in having a bilobed posterior termination, apparently agreeing in this respect with the last molar of *E. plicidens*; the enamel and dentine folds, however, extend across the crown, like those of the last molar of *E. fossilis* as figured in the 'Fossil Mammals.' It has been observed by Prof. Owen long ago, that the fossil horse had proportionally a larger head than obtains in the domesticated races. While this is, no doubt, the case to a considerable degree, still, were we to assume that the fossil horse had as large a head as the recent, in proportion to the size of the molar teeth (which, in the case of the former, are often found detached), we should be somewhat mistaken. At least, in the fossil under consideration, the majority of the teeth are nearly as large as the teeth of the cart-horse of the present time, while the head itself has evidently been a good deal less. However, to show the relative sizes more clearly, I will, as far as practicable, give the measurements of the fossil cranium, the molar teeth, and the tibia, together with similar measurements of a Scottish pony and a cart-horse, the latter appearing to me to be a fair representative of its class:—

	Scottish pony. inches.	Fossil. inches.	Cart-horse. inches.
Length of the intermaxillary bone (measured over the curve) from the edge of the alveolar cavity of the first or middle incisor to the termination of the ascending apophyses	7 1/4	8 1/8	9 1/4
From the anterior edge, in front of the canine tooth of the superior maxillary, in a straight line to the orbital cavity	9 3/8	10 1/4	12 1/2
Breadth of the superior maxillary, from the anterior edge of the first molar to the upper edge, at the point where the intermaxillary bone terminates	3 3/4	4 1/8	4 1/2
Dimensions of the molar teeth.			
Antero-posterior diameter of the crown of the first molar	1 1/4	1 3/8	1 1/2
Antero-posterior diameter of second molar..	1	1 3/16	1 3/16
,, ,, third molar ..	7/8 1/16	1 2/16	1 3/16
,, ,, fourth molar..	3/4 1/16	1	1 1/16
,, ,, fifth molar....	3/4 1/16	1 1/16	1 2/16
,, ,, sixth molar ..	1 1/16	1 2/16	1 1/4 1/16
	5 7/8	6 7/8	7 3/8
Dimensions of tibia.			
Extreme length, including tibial spine or central process in the knee-joint.........	13 1/4	13 5/8	16
Greatest transverse diameter of the head ..	3 3/4	3 5/8	4 7/8
,, ,, of the distal end	3	2 7/8	3 7/8
Least circumference of the shaft..........	4 5/8	4 3/8	6 1/2

The foregoing dimensions will show the different sizes of the teeth and bones. And as the length of the tibia (minus the central process in the knee-joint) in general averages one-fourth of the height of the horse to which it belongs, in this way a fair approximation to the sizes of the animals under consideration may be obtained. It will be observed, taking the measurements of the crania from the anterior edge of the superior maxillary to the orbital cavity, that this part in the fossil is $\frac{3}{4}$ inch longer than that of the pony, and $2\frac{1}{2}$ inches shorter than the same part in the cart-horse. As this part of the horse's skull is on an average about 1 inch longer than the space from the anterior margin of the orbital cavity to over the occipital condyles, it will be apparent that, if we make a proportional allowance for this part, absent in the fossil, and of course add for the fore part of the intermaxillary bone, we shall not be far wrong in estimating the fossil skull at 2 inches longer than the pony's, and about 5 inches shorter than the skull of the cart-horse; while it will be seen that, taking the total of the antero-posterior diameter of the molars, irrespective of details, these organs in the fossil exceed those of the pony by 1 inch, and are only $\frac{1}{2}$ inch less than those of the cart-horse.

XXV.—*Some Remarks on the Succession and Development of Animal Organization on the Surface of our Globe, in the different Periods of its Existence.* By J. Van der Hoeven, Professor of Zoology, University of Leyden*.

It requires but little knowledge of organized bodies to remark that there is a great difference in their structure, and that some are more, others less complicated. This greater development depends not only on the presence of parts or organs which are absent in more simple organisms, but also on modifications in the structure of parts which exist as well in more simple as in more perfect species. In the animal kingdom, for instance, there are species which are devoid of the organs of the senses of sight and of hearing, so important in man; others which have these organs, but in a very different degree of complication. Thus the organ of hearing presents a greater number of distinct parts in mammals than in fishes; and thus, too, the eye is in general more complicated, more moveable, more nicely protected in the former than in the latter. It is needless to give a larger number of examples of this diversity of perfection. From the observation of this diversity originated a conception which seems

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* Written in Dutch, in 1858, before the publication of Mr. Darwin's work. Communicated by Dr. J. Barnard Davis, F.S.A.